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Eriochrome Black T Decolorization with Active Carbon and Hν/Tio$_2$: Modeling and Process Optimization

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Extended Abstract

Azo-dyes are one of the main classes of dyes that, due to their toxicity and high solubility in water, can pollute water basins. As a result of the chromophore group –N = N– in the aromatic structure of the compound, the azo compounds are usually non-biodegradable and resistant to the action of natural hν radiation and oxidizing agents [1]. Eriochrome black T (EBT) is an azo dye used in many industries (textile, rubber, paper, leather dyeing, printing, pharmaceutical industry, cosmetics) or as a complexometric indicator [2] and its removal from effluents is of outmost importance. Because EBT is stable in the presence of light, heat and is refractory to oxidative biodegradation, even at low concentrations, it is difficult to remove. Its toxic effect can be exacerbated by the fact that its anaerobic degradation results in carcinogens intermediates such as naphthacinone [1].

In this work, the processes of EBT decolorization is modelled and optimized using Minitab and a series of swarm-based metaheuristics (Particle Swarm Optimization, Bacterial Foraging Optimization and Bees Algorithm). The dye decolorization was performed by two methods: adsorption on active carbon (CA) and photocatalytic degradation with TiO_2 (PD). The study aimed to show that optimization strategies can improve the process without the need of additional experiments or other resource consuming strategies. The analysed parameters were: the amount of adsorbent and photocatalyst (g/mL), the contact time (min) and the initial concentration of the dye (mg/L). By applying the response surface methodology, the mathematical models of the two processes were determined. The correlation between the models and the practical data were 88.07% for CA and 97.76% for PD. Based on the identified models, the dye decolorization efficiency was predicted and experimentally validated. Following the optimization of the CA decolorization process, an increase in yield was obtained from 91.83% (yield obtained during determinations) to 99.98% (yield obtained at validation), while in the case of PD, the increase was from 75.35% to 98.37%.

Compared with other photocatalytic studies (where it was observed a 99% efficiency after 200 min. [3], 99% using catalysts based on ceria and zinc in 120 min., or 83% applying UV light without catalyst for 120 min. [4]), in the current study, a 97.92% efficiency was obtained after 31.3 min, indicating that the applied modelling and optimization strategy is efficient in improving the process and reducing the time necessary for obtaining good results.

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